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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of Coal Mining Machinery

PUBLISHED MONTHLY BY
THE TEXAS COMPANY, U.S.A.
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICANTS
For Coal Mining Machinery

BELOW GROUND

DRILLS, HAMMERS, STOPERS, PUNCHERS AND PICKING MACHINES

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(*Other Types*)	TEXACO STAR GREASE NO. 3
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Cutter Chains	TEXACO BLACK OIL
Wheel Bearings	(SEE MINE CARS)

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(*Where Grease is Advisable*)	TEXACO STAR GREASE NO. 00
Exposed Gears	TEXACO CRATER COMPOUND NO. 1 OR 2
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Bearings (*Grease Lubricated*)	TEXACO STAR GREASE NO. 3
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Air Cylinders	TEXACO CAPELLA OIL
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(*Enclosed—Bath Lubricated*)	TEXACO THUBAN COMPOUNDS

ABOVE GROUND

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(*Grease Lubricated*)	TEXACO STAR GREASE NO. 3
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WIRE ROPE

General Service	TEXACO CRATER COMPOUND NO. 1
Water Conditions	TEXACO CRATER COMPOUND X

TIPPLE EQUIPMENT

BREAKERS AND CRUSHERS

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(*Grease Lubricated*)	TEXACO STAR GREASE NO. 3
Gears and Chains (*Bath Lubricated*)	TEXACO THUBAN COMPOUND "B"
Gears (*Exposed*)	TEXACO CRATER COMPOUND NO. 1

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Exposed Gears	TEXACO CRATER COMPOUND NO. 1 OR X
General Exposed Parts	TEXACO BLACK OIL

CONVEYORS AND PICKING TABLES

Roll Bearings (*Grease Lubricated*) *according to type*	TEXACO MARFAK GREASE OR TEXACO STAR GREASES
(*Oil Lubricated*)	TEXACO ALEPH OIL

NOTE:—For Texaco lubricating recommendations for other equipment not chiefly confined to the mining industry see the following issues of "Lubrication":

Air Compressors.....March, 1924	Gears.....June, 1925
Boiler Room Equipment...March and May, 1926	Pumps.....May, 1925
Car Dumpers, Cranes, etc..December, 1925	Steam Engines.....August, 1924
Electric Motors.....October, 1925	Steam Turbines.....February, 1925

Gasoline Engines.....Texaco Lubrication Charts

LUBRICATION

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Lubrication of Coal Mining Machinery

VOLUME production of coal, today, requires that it be removed with as little labor as possible from the seam, and rendered suitable for loading and moving from the mine to the breaker or point of shipment with a minimum of handling.

Pick and shovel work where any amount of tonnage is involved is practically a thing of the past. Below ground, it has been supplanted by the electric or pneumatic drill, the puncher, the mechanical coal cutter, the automatic mine car loader, and the electric hoist.

While the prevailing demand for increased production has been an outstanding factor in this adoption of mechanical methods of mining, the necessity for reduction of unit costs per ton has of course been influential to a large extent.

The usage of mechanical equipment has increased the first cost, and added to such items as maintenance, depreciation and overhead. It has likewise, required an improvement in labor conditions, intelligence and ability of the miners. For coal mining machinery is especially subject to wear, breakdowns and the necessity for repair.

Careful, intelligent operation is, of course, a decided element in reducing the above. In fact, an appreciation of the importance of lubrication,—i.e., judicious selection of oils and greases by the management and intelligent application by the operators will be the salient factor in the mining of coal with a minimum of expense for machine repair, parts replacement and depreciation.

MINING MACHINERY

Coal mining starts with the drilling, punching, or cutting of the seam.

Drilling is necessary where coal is to be broken by blasting. In this work the pneumatic or electric drill is extensively used. Drilling preparatory to blasting is quite prevalent in the anthracite fields. Bituminous coal, on the other hand, is more frequently mined by means of cutting machines.

DRILLING

There are two distinct types of mechanical drills in use today in coal mining. They involve either the principles of rotary motion, or percussion or impact.

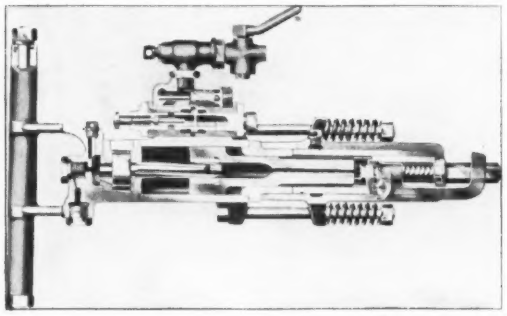
Percussion Type Drills

Where percussion is employed, air pressure acts on the tool mechanism in much the same manner as steam acts on the pistons of a steam engine. In other words, the tool mechanism involves one or more cylinders with suitable companion pistons, and either an arrangement of valves for the admission of air at the proper time, according to the number of strokes per minute or percussive frequency required; or, as in the valveless type, a piston which acts as its own valve.

Just as in the reciprocating steam or internal combustion engine, where valves are required, there will usually be two sets involved; i.e. (a) Those which, by virtue of their timing, control the frequency with which the air pressure is allowed to react on the piston; and (b) The throttle valve whereby the operator is able to control the amount of air admitted to the tool.

We are, therefore, confronted with more or less the same conditions of wear as in the reciprocating engine. In the matter of lubrication, however, and the reduction of this potential metallic wear between cylinder walls and pistons, etc., an opposite consideration is

involved. Instead of relatively high temperatures as in a heat engine, we will have low temperatures to deal with. Steam gives off heat; petroleum fuels in their combustion



Courtesy of Ingersoll-Rand Co.

Fig. 1—Sectional view of a "Jackhammer" drill. Lubricator is shown located in the valve chest. Lubricant is distributed to wearing elements by incoming air.

develop heat; air, however, in its expansion and passage through pneumatic drills, unless preheated, absorbs heat from its surroundings.

In consequence, unless atmospheric temperatures are relatively high, this expansion temperature may run quite low. So pneumatic tool lubricants must be able to withstand low temperatures as a general rule.

Rotary Drills

The rotary drill will in general be of either the motor-driven auger type with suitable reduction gearing, or, it will comprise a number of air cylinders with their respective pistons. In drills of the latter type there will, in addition, be the crankshaft and connections for transformation of reciprocating motion into rotary motion; a train of gears for bringing about speed changes, and the requisite gear and crankcase.

Lubrication

In drills involving gearing the matter of lubrication requires that gears, crankshaft bearings and cylinders must be served. As a rule this can be adequately taken care of by means of two lubricants; one, of the nature of a liquid grease or petrolatum to serve the gears and crankcase bearings, etc., the other, an oil to serve the cylinders.

In the more modern type of drill the crankshaft will frequently be equipped with ball bearings, the connecting rod being furnished either with plain or roller bearings. It can be appreciated, therefore, that the crankcase lubricant must be such as to adequately lubricate these varied bearings, with the least amount of internal friction and no tendency to separate. In consequence, greases for this purpose should be selected with the utmost care.

In both crank and gear cases, by virtue of their dust proof construction, there is but little possibility of dirt or dust entering to contaminate the lubricants. They should, therefore, function effectively for indefinite periods with but little renewal. In operation the heaviest duty is imposed by reason of the churning action which such lubricants are subject to.

In mine drills, as stated, there will be possibility of abnormally low temperatures, due not only to the moisture, which is usually in the air, but also the fact that narrow, tortuous air passages must generally be traversed in the course of expansion. In air drills it is frequently customary to "lubricate the air" prior to its delivery to the tool, a suitable lubricating device being installed in the air line a short distance back from the throttle valve.

Water

It is relatively difficult for any lubricant to withstand water and dirt conditions however suited it may be to the actual operating requirements. Water for example will tend to wash off the lubricating film from wearing surfaces. It is for this reason that compounded lubricants, i.e., mineral oils containing more or less animal oil or soap in compound are recommended for the lubrication of such equipment as hammer drills where operating with water. Such lubricants function on the same principle as do steam cylinder oils. In other words they emulsify with water, by virtue of their fatty content, creating an adhesive emulsion which adequately resists the washing effects of water and sticks tenaciously to all wearing elements.

But such lubricants are only recommended

Courtesy of Sullivan Machinery Co.

Fig. 2—An automatic line oiler being used on a drifter. This oiler is inserted in the air line a few feet back from the drill. It requires but two fillings per eight-hour shift.

for air drills wherein water is intentionally mixed with the air to serve the purpose of washing cuttings from the hole, in much the same manner as a soluble oil solution washes

metal cuttings away from the tool in the machine shop drill, etc. Where pneumatic tools are designed to function dry, they should be absolutely dry—that is, free from moisture as far as possible. On such equipment straight mineral lubricants are generally used.

Dust and Dirt, Etc.

Dust and dirt which may gain entry through careless handling, not to speak of the dirt which may be carried through the drill by the air itself, will also be detrimental and cause abnormal wear.

Clean, pure air is not always available. This will all depend upon the location of the compressor, its air intakes, whether or not air filters are installed, and the cleanliness of the air coolers and air lines.

Furthermore, there will also be the possibility of particles of rust being carried along by the air, especially where lubrication has not been adequate in the protection of those parts of the system exposed to moisture. Then too, particles of rubber from the air hose and gaskets may also find their way into the air passages and cylinders along with other foreign matter, to materially interfere with the free operation of the tool.

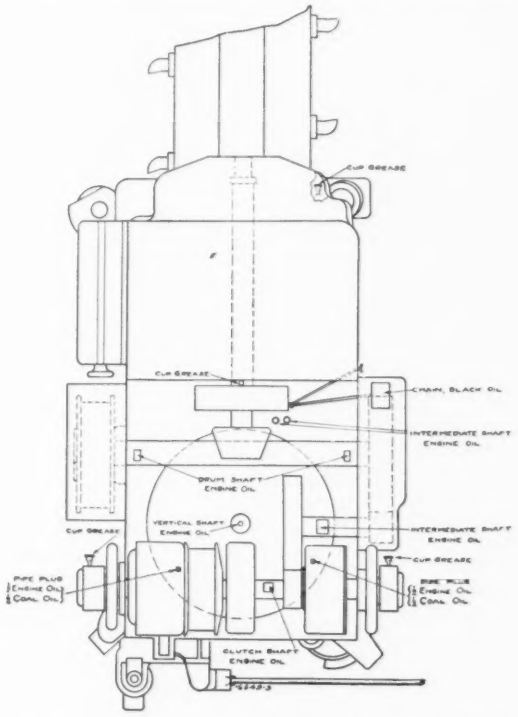
A wire strainer of suitable fineness located in the inlet pipe will be found to be advantageous in the removing of much of the above foreign matter and the protection of the working mechanisms of the drill.

Applying Lubricants

To further protect mine drills against the entry of foreign matter, care must also be exercised in regard to the feeding of the lubricants.

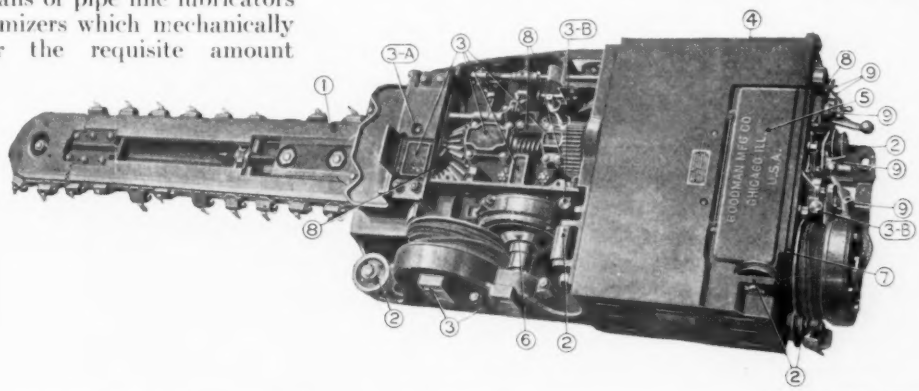
Where automatic lubrication is provided for by means of pipe line lubricators or atomizers which mechanically deliver the requisite amount of oil to the air lines, there will be the least possible chance of dust or dirt being carried in, provided that the oil is properly stored and handled.

Where drills must be periodically oiled by hand, however, in the absence of automatic means of lubrication, there may be more possibility of accidental entry of dust or dirt occurring. At best, operators' hands will be dirty, and in mines the atmosphere will often be laden with dust. Of course under such conditions the lubricants for current usage should be stored and handled with the utmost care.


CUP GREASE
CHAIN, BLACK OIL
INTERMEDIATE SHAFT ENGINE OIL
DRUM SHAFT ENGINE OIL
VERTICAL SHAFT ENGINE OIL
PIPE PLUG ENGINE OIL & COAL OIL
PIPE PLUG ENGINE OIL & COAL OIL
CLUTCH SHAFT ENGINE OIL

Courtesy of The Jeffrey Mfg. Co.

Fig. 3—Line sketch of a "shortwall" coal cutting machine showing respective points requiring oil or grease.

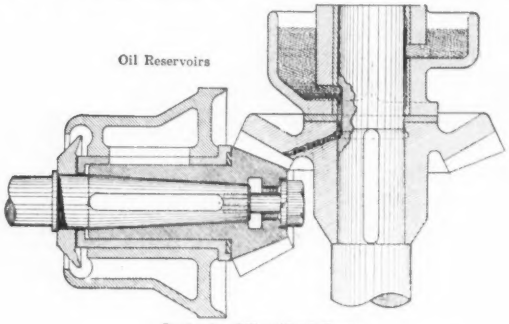


Courtesy of Goodman Mfg. Co.

Fig. 4—Lubrication chart of a "shortwall" cutting machine. 1 and 2 show the cutting chain and sheaves—oil lubricated; 3 and 3-A are wool-waste packed bearings; 3-B—The armature bearings; 4—The controller contacts; 5—The commutator; 6 and 7—The variable feed and tail rope drums,—oil lubricated; 8—The gears,—to be lubricated by non-fluid oil; and 9 the operating handles and levers—oiled once a shift.

PUNCHING MACHINES

Punching or pick machines in principle, are much similar to large sized drills. They are advantageous for usage where coal seams run horizontally or at an angle not exceeding 15 degrees. The average punching machine is driven either by electricity or compressed air, according to availability of such power.



Courtesy of Sullivan Machinery Co.

Fig. 5—Oiling plan for the bevel gears on a continuous coal cutting machine. Note oil reservoirs in top bearing of intermediate shaft, which serve both the shaft bearing and gears, via suitable oil passageways as indicated.

In general appearance and ability both types of punches are much alike. The extensive use of electric power in many mines is of course, an influencing factor in furthering the usage of the electrically operated machine.

The average punching machine is used for undercutting work. It is advantageous in that it is cheap in first cost, easily moved by hand, relatively simple in construction and capable of cutting in such a manner as to result in production of a high percentage of lump coal without excessive explosives.

On the other hand, a considerable strain is imposed upon the operator in its handling due to the continuous percussive effects. Furthermore continuous cutting is not practicable and the cost of cutting is comparatively high.

Lubrication

The lubricating problems of compressed air and electric driven punching machines are so akin to those problems involved in the operation of percussion type drills that reference is made to the discussion pertaining to such equipment.

Essentially a low pour test, medium viscosity oil will serve for normal conditions of air cylinder lubrication. For other parts of the air driven puncher, as well as the electric machine, including the reduction gears, motor bearings, etc., a medium bodied grease compounded with a highly refined low pour test straight mineral oil, will be satisfactory.

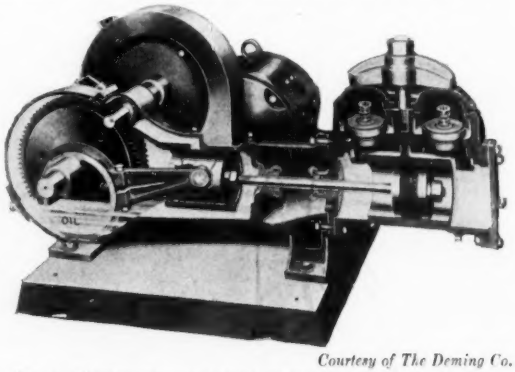
CUTTING MACHINERY

In this category can be included all those machines which serve to accomplish continuous cutting of coal seams preparatory to breaking up and removal of the coal. Dependent upon such factors as the hardness of the product, the character of impurities, the condition of top and bottom walls, the pitch of the seam, the width and thickness of this latter, etc., such machinery will be variously known as the Breast, Shortwall, Overcutter, Longwall, or Arcwall, according to the specific features in design to meet the above conditions.

The Breast and Shortwall or continuous cutter are undercutting devices. The latter is advantageous in that it maintains a high cutting speed, involves comparatively no hazards and gives a clean, uniform cut with no ribs to interfere with subsequent blasting or shooting. It is a ruggedly built device, and hence adaptable for service in the hard coal fields.

The Breast machine operates on the principle of driving a chain, containing a number of barbs or picks, into the underside of a vein. In the breast machine the chain operates around the periphery of a triangle, the base being forced into the coal while the apex remains at the machine. This cuts a kerf several inches thick on the underside of the seam the width of the triangle base and 6 to 8 feet deep. After the triangle has reached the depth desired it is withdrawn, the machine moved to one side and another cut made. This is repeated across the face.

The Shortwall or continuous machine operates in a somewhat similar manner to the Breast except instead of a triangular cutter, a long and narrow one is used, which is capable of cutting sidewise as well as on the end. With this machine a cut can be run across the face of the seam continuously and time and labor saved.



Courtesy of The Deming Co.

Fig. 6—Phantom view of a double-acting piston mine gathering pump. Note oil reservoir in base of crankcase. For such pumps a highly refined straight mineral steam cylinder oil has been found most suitable, especially where water conditions and emulsification must be counteracted.

The Longwall machine in turn, is a type of continuous undercutter, advantageous for usage where the roof is tender. It usually occupies not more than three feet between the coal face and prop line.

Principles of Lubrication

The lubrication of these machines varies considerably, depending on the design. Some machines can be lubricated by a soft grease or an oil of about 200 seconds Saybolt viscosity at 100°F. In other cases where gears and bearings of these machines are oiled through the same channel this is best accomplished with a heavier oil applied immediately after cutting each place, while the machines are hot.

The armature ball bearings on many machines must be oil lubricated using a high grade mineral oil of about 200 seconds viscosity, for in order to keep coal and grit out the oil holes are made so small that only a light oil will reach the bearings. Where a dust tight cap and large oil holes are provided however, a light grease is generally preferable.

The cutter chains can generally be lubricated with waste engine oil or black oil. Care should be taken to clean both the chains and machines quite often. They become dirty very quickly and their life will be greatly prolonged and their efficiency increased by close attention. Some operators soak the chains in oil after cutting each room.

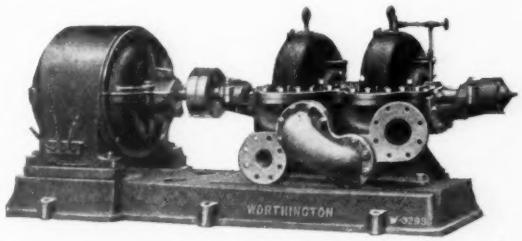
The wheels of mining machine trucks and trailers are similar to those found on mine cars and their lubrication will be discussed under that title.

Mining machines when loaded for travelling drive the trucks through a worm and gear, which in turn drives the wheels by means of chains. All such parts are best lubricated with a medium bodied gear lubricant, of highly penetrative and adhesive characteristics.

Parts Replacement

In connection with lubrication it is important to note the extent to which it can be relied upon to counteract the effects of wear and tear. This latter will be extensive on the wearing elements of any coal mining machine, regardless of the attention given to lubrication. The presence of excessive amounts of coal dust, and other abrasive matter, and the possibility of dampness all render the attainment of effective lubrication quite a problem.

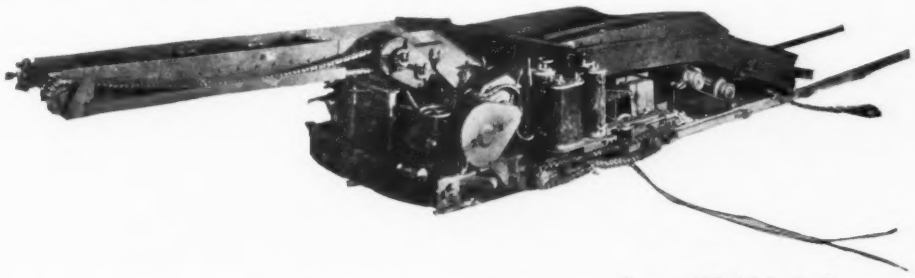
Cost of upkeep and repair will therefore be comparatively high in many mines. Certain gears and bearings will wear more than others, regardless of lubrication. The best we can hope from this latter is that it will reduce the rate at which such wear takes place, keeping gears in proper mesh as long as possible, and preventing bearings from pounding. Improper meshing of gear teeth, or bearings of abnormal clearance are in fact, most conducive to further difficulties, not to mention added wear and the possibility of breakdown.



Courtesy of Worthington Pump & Mach'y Corp.

Fig. 7—A motor-driven multi-stage volute pump, adaptable to mine service. Bearings are ring-oiled, a ball thrust bearing assures lateral alignment of the impeller.

Where it is necessary to renew gears or bearings it will, therefore, always be advisable to investigate whether or not it is well to renew the entire train, or all the bearings of same. To merely install a new gear, or renew the bearing of a gear shaft, will not insure correct meshing in case the companion gears or bearings are worn to any great extent. In fact this would only lead to more rapid wear of the new gear or pinion. The use of heavier grades of gear lubricants might offset high tooth clearances to a certain extent, but the increase in power consumption involved due to possible drag would certainly not render this economical from an operating point of view.

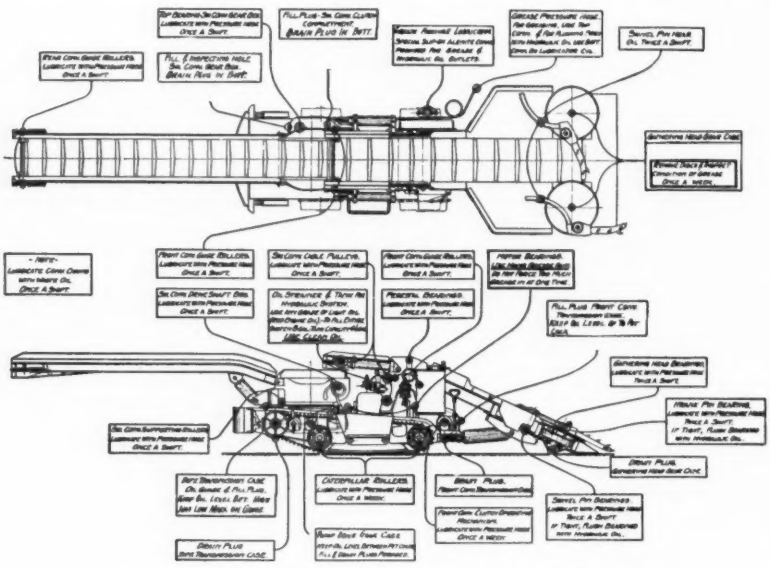


Courtesy of The Coloder Co., Inc.

Fig. 8—Side view of a modern coal loading machine. Note details of construction and provisions for protecting wearing elements as far as possible by suitable housings, thereby insuring more efficient lubrication.

MECHANICAL LOADERS

Power mining and the necessity for increased production has brought the mechanical loading machine to the fore as a decidedly advantageous piece of equipment. Essentially its purpose is to transfer coal from the working face to the carrier or mine car, which in turn carries it to the tipple or breaker.



Courtesy of Joy Manufacturing Co.

Fig. 9—Lubrication chart of a mechanical coal loading machine. Constructional details are clearly shown.

While there are quite a number of types of coal loaders in more or less common usage today, those most extensively employed involve the principles of the conveyor, the scraper or scoop, or the shovel or gathering machine.

In construction three distinct units are in general involved: (1) The chassis or tractive element which enables movement over the mine floor. (2) The gathering device, shovel, or as it is sometimes termed the front conveyor, which gathers or accumulates the coal after the latter has been "shot" or broken away from the seam by blasting; and (3) The rear conveyor which receives the coal from the front conveyor, to in turn deliver it to the mine car.

The conveyor unit or scraper which serves to carry the coal as scooped or otherwise accumulated by the front section, shovel or gathering device is in principle much the same on practically any type of loader. This holds true likewise in case of the tractive elements.

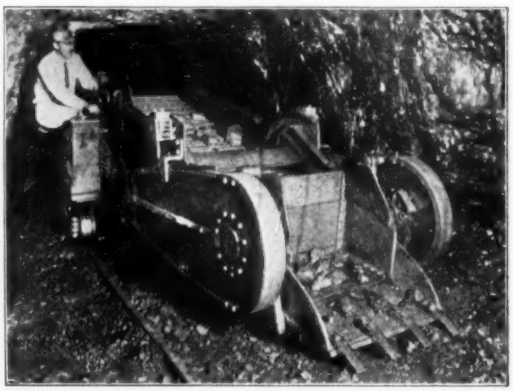
The gathering mechanism on the other hand is quite distinctive, according to the design of the loader. In digging type machines it involves a shovel or ram which can be forced under or into the loosened coal either by driving the tractive elements ahead, or by means of a suitable arrangement of cables, chains and levers.

Gathering machines in turn, make use of revolving or reciprocating arms which continuously dig into the loosened coal to drag it onto the conveyors for subsequent delivery to the mine cars. With those machines of the strictly conveyor types, however, coal may be loaded by hand or some such device as mentioned above.

Lubrication of Coal Loaders

In view of the fact that coal loading machinery must function in intimate contact with abrasive materials which are decidedly prone to promote wear, the matter of lubrication must be given careful attention.

As a general rule gears, chains and bearings will be involved according to the design of the machine. In addition, on certain loaders built for hydraulic operation oil will be required in the hydraulic system. Such oil also serves to lubricate the interior parts of such a system.



Courtesy of Myers-Whaley Co. Inc.

Fig. 10—Typical view of a mechanical coal loader of the shovel type at work. Note conveyor in the rear.

Automatic lubrication has been extensively developed in the industry, the loading machine being given considerable attention in this regard. This may involve merely the lubrication of gearing and gear shaft bearings by

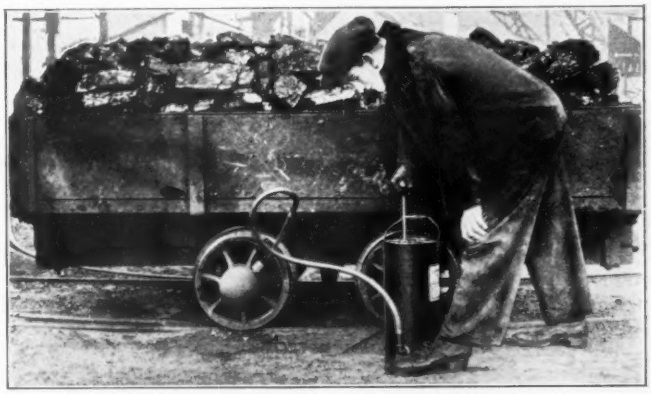
splash from the oil in a reservoir which is formed by the gear case, or some form of pressure lubrication may be employed using either grease or oil according to requirements of the wearing elements.

Automatic lubrication is advantageous in that it usually enables the lubricant to more effectively perform its intended function of reducing metallic friction and wear. Furthermore it promotes economy of lubricants, for as a general rule lubricating systems will be of more nearly an oil-tight nature. Such construction has a further advantage in that it more completely prevents entry of coal-dust, other abrasive foreign matter or mine waters.

For the lubrication of all such gears, chains and bearings as can be served from a central reservoir as above, it will usually be advisable to use a relatively heavy bodied, straight mineral oil. Such a product will follow all gear and pinion teeth readily, will penetrate throughout all normal bearings clearance spaces and will insure that chain roller or link mechanisms will receive adequate lubrication.

It is also quite possible to use a grease of normally plastic consistency in certain gear cases. In fact this is the recommendation of some builders. Care should be taken, however, that any grease used is compounded with a high grade of low pour test mineral oil, otherwise under low temperature conditions there will be possibility of congealment and lack of sufficient lubrication especially if bearing clearances are low.

On all such machines for coal loading purposes as may involve hydraulic operation for manipulation of the gathering, shoveling or conveying elements, a high grade machine or engine oil of approximately 200 seconds Saybolt viscosity at 100°F., should be used. Such a product if of sufficiently low pour test, should function effectively and give adequate lubrication to all plunger rods, etc. The necessity for low pour test is to insure against the oil becoming so sluggish at low temperatures as to require excessive power consumption during operation.

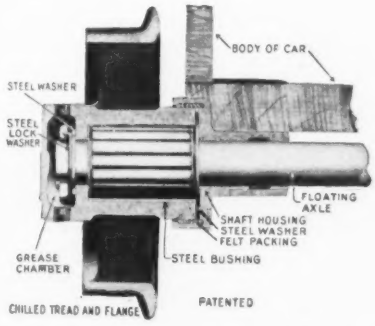


Courtesy of Lincoln Steel & Forge Co.

Fig. 12—Greasing mine car wheel bearings is frequently a sloppy, tedious job, unless carried out by some form of automatic pressure lubricator as above.

For other parts of the average coal loader such as exposed chains, tractive elements, bearings, etc., which may require periodic hand lubrication, machine oil of about 200 seconds Saybolt viscosity, or a medium compression cup grease should be used.

For exposed gears, a straight mineral, semi-fluid lubricant of from 1000 to 2000 seconds Saybolt viscosity at 210°F., will be adaptable, insuring adequate protection of gear teeth with a minimum of loss through dripping or the action of centrifugal force.



Courtesy of Ottumwa Iron Works

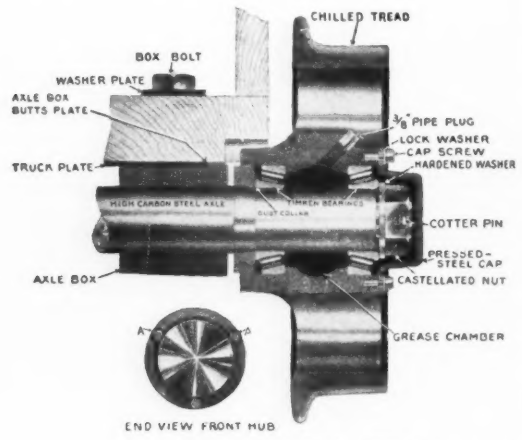
Fig. 11—A roller bearing mine car wheel. Details of construction are clearly shown.

MINE CAR WHEEL LUBRICATION

The practical necessity for mine cars in virtually every phase of coal mining renders a discussion of lubrication of their wheel bearings of vital importance. In effect the efficiency of the mine car controls the rate of production, just as is true with many other types of materials handling equipment.

The volume of lubricants required for mine car bearings normally exceeds the amount used for any other type of mining machinery. As originally designed mine cars were equipped with plain bearing axles. Lubrication of these latter was, therefore, a matter of daily routine, black oils or cheap greases being applied by hand.

Such lubrication was usually undependable, the labor cost was abnormally high, and there was no assurance of positive lubrication or protection of the bearings against the entry of moisture or abrasive foreign matter.



Courtesy of Southern Wheel Company and Timken Roller Bearing Company.

Fig. 13—Cut-away view of a mine car wheel bearing equipped with tapered roller bearings: Note dust collar and bearing cap to prevent entry of foreign matter, the ample size of the grease chamber and relative location of the bearings.

To reduce the ultimate cost of replacement and to bring about labor economies careful attention has, therefore, been given to improvements in mine car wheel bearing design. Positive and relatively automatic lubrication must be attained if mine cars are to stand up under the higher speeds resulting from the use of the mine locomotive. Reduction in load required to move the cars means the possibility of handling more cars per train. This is decidedly advantageous in the interests of increased production.

Types of Bearings

The average mine car will be equipped with

1. Plain bearings.
2. Cavity type, self-oiling wheels.
3. Solid Roller Bearings, or
4. Flexible Roller Bearings.

These may be installed on fixed or floating axles.

Plain Bearings

Plain bearings, where still in use, are in general so constructed as to enable the use of oil-saturated wool-yarn or waste packing. In brief, bearing design is much similar to that so extensively used in the railway service.

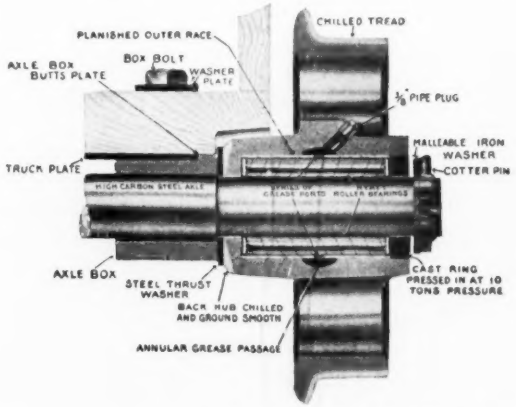
Provided that regular attention is given to loosening, and re-saturation of the waste or oil-carrying material with a suitable grade of straight mineral machine or car oil of approximately 500 seconds Saybolt viscosity at 100°F., or a light grade of liquid grease, very effective lubrication should result.

The utmost care, must always be observed to prevent matting or glazing of such materials, for this will reduce the capillarity of the latter, preventing the requisite amount of lubricant from being transmitted to the rotating axle surface.

The packing of journal or car wheel bearing boxes is quite an art, as is also the determination of the extent to which proper lubrication is being obtained. The waste or wool-yarn should in the first place, be of good quality, long strand material. It should be saturated in accordance with standard railway practice, for a period of 48 hours at 70°F., then drained until the oil content is approximately 2 pints per pound of waste; usually this will require about 24 hours. It should then be packed in a homogeneous mass, not too tightly, and yet in a sufficiently compact manner to insure continued contact with the axle. At periodic intervals it should be loosened to maintain its oil transmitting ability as high as possible.

Cavity Type Wheels

As generally understood, the cavity type of wheel involves an oil or grease reservoir around the hub. During rotation the lubricant is fed to the axle or journal through port holes staggered in the hub. Such delivery of lubricant, however, only occurs when the car is idle or



Courtesy of Southern Wheel Company and Hyatt Roller Bearing Company.

Fig. 14—Details of a mine car wheel bearing wherein flexible roller bearings are used. Note that the roller cage is absolutely protected by the chilled back hub of the wheel.

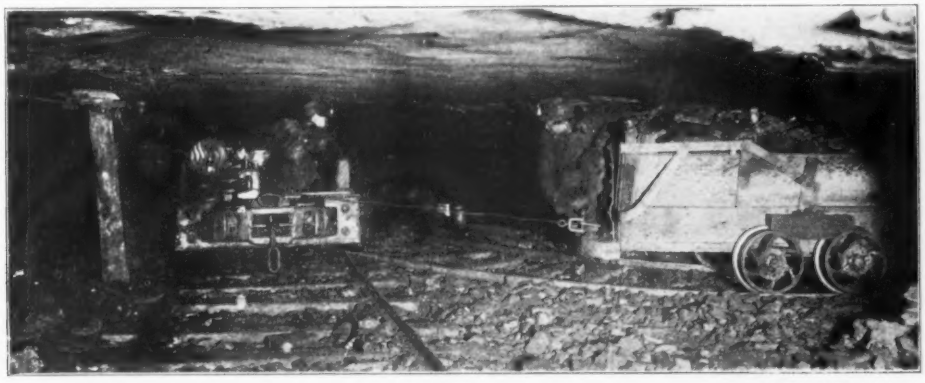
running slowly. At higher speeds centrifugal force tends to carry the lubricant to the outer surface of the reservoir.

Due to possibility of leakage, care should be observed in regard to the amount of lubricant

used. In general the stationary level should be maintained on a line with the lower part of the axle.

For bearings of this type the lubricant should be comparatively heavy in body, and yet have a sufficiently low pour test to insure proper flow through the distributing ports. A highly refined straight mineral engine or car oil of about 500 seconds Saybolt viscosity at 100°F. will in general be best suited to the operating conditions, and will insure most complete protection of the bearings.

Where grease is desired or deemed necessary by reason of possible leakage of oil, a semi-fluid product compounded with low pour test mineral oil will adequately serve the purpose.

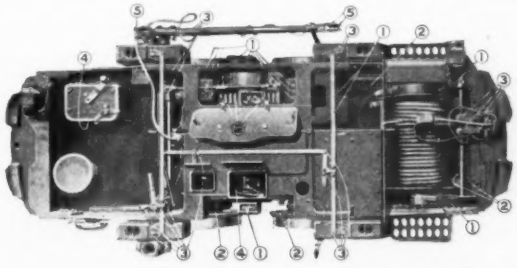


Courtesy of The Jeffrey Mfg. Co.

Fig. 15—The electric mine locomotive in operation. Note nature of working conditions and the potential possibilities of impaired lubrication on wheel bearings, etc.

Roller Bearings

The manner of installation of both solid and flexible roller bearings is shown in detail in the accompanying illustrations. Roller bearings, regardless of their type, are decidedly positive, automatic and economical from a lubricating point of view. By reason of the careful construction all lubricants used should be of the highest degree of refinement, and selected with the utmost caution. The function of these latter is more to protect the rolling elements against corrosion, than to actually lubricate the contact surfaces.



Courtesy of Goodman Mfg. Co.

Fig. 16—Lubrication chart for an electric driven mine locomotive. 1—Indicates axle boxes and other lubricating boxes for serving plain bearing armature shafts, reel transmission shafts, etc., oil-soaked wool yarn is recommended for these boxes. 2—Shows the gears, drive chains, guide shafts, reel spooler screw, etc. 3—The brake rigging, sand rigging and cable spoolers which should be oiled daily. 4—The controller contacts, and commutator, and 5—The trolley wheel and bracket.

In mine car service, soft or semi-fluid greases are usually recommended for roller bearings. Where the latter are of solid, cylindrical or tapered construction a somewhat more inert grease will be advisable, than on hollow flexible bearings. It will be found that such a product will furnish a better cushion between the axle and rollers than a more liquid grease. Furthermore, it will also form a better seal against possible entry of dust or dirt.

For flexible roller bearings, however, the lubricant should be a semi-fluid or so-called liquid grease. The usual construction of such bearings provides for the hollow spaces within the rollers serving as grease reservoirs.

In consequence the lubricant must be sufficiently fluid to readily pass through and penetrate to all the surfaces of contact. It should never remain inert within the rollers.

Properly lubricated roller bearings which are constructed of a relatively oil and dust-tight nature should not require re-lubrication more frequently than once every six months. The lubricant should be applied by a pressure gun of capacity commensurate with the proper amount of lubricant per bearing. In this way just the right amount, as recommended by the manufacturers, can be injected, with the least possibility of subsequent leakage or development of abnormal internal friction.

MINE LOCOMOTIVES

In the modern coal mine the mule is being largely replaced by electric or air driven locomotives. Electric locomotives are of low, enclosed construction and may be driven by

power from a trolley wire or from storage batteries. The trolley system is more apt to be used in main gangways and the battery in shorter leads.

Air driven locomotives derive their power from storage tanks, where the air pressure may be as high as 1500 pounds per square inch. These are charged by air compressors at the surface.

Courtesy of American Blower Co.

Fig. 17—View of a mine fan showing relative size, the exposed nature of the bearings and means of drive. Effective bearing lubrication is most important as the fan must never be stopped unexpectedly.

Locomotive axle bearings are lubricated according to the type of bearing; the same recommendations apply as for mine cars.

Gears, in turn, require the use of a straight mineral, residual lubricant of about 1000 seconds Saybolt viscosity at 210°F. Such a product will adhere tenaciously to the gear teeth and overcome vibration and wear. At the same time it will be sufficiently fluid at low temperatures to follow the teeth without channeling. This same lubricant should also be used on chain drives.

Where gears and chains are enclosed in oil-tight housings, a somewhat lighter lubricant can be used to advantage.

On locomotives which are driven by compressed air, the cylinders should be lubricated by a medium bodied air compressor oil. Low pour test is absolutely essential. These cylinders generally exhibit a heavy frost line, indicating a low temperature from the expansion of the air.

VENTILATION—FANS AND BLOWERS

One of the most important factors in coal mining is the ventilating system. There are always deadly as well as inflammable gases concealed in the various coal pockets, and even the coal dust itself may be as explosive as the gases if it comes in contact with a spark or flame. These gases therefore must be continually removed in order to make a mine safe and workable.

This is accomplished by means of large fans, sometimes 10 to 20 feet in diameter which remove the foul air, and often-times blow in fresh air simultaneously, via suitable shafts and ducts.

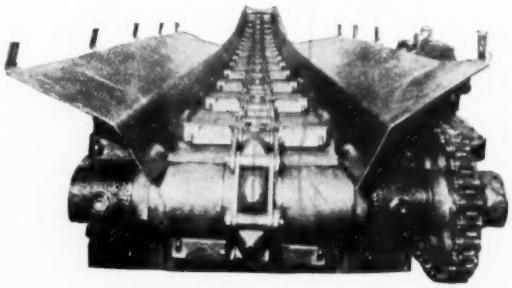
When the suction system is used the fresh air enters through the working or hoisting shafts. The various gangways, headers, galleries, etc., are so arranged that there is always a current of air in them. As soon as the coal is exhausted from a header the latter is closed up by "brattice work," so that the air can be forced through another header that is being worked.

Lubrication

The fans used to bring about the air circulation are driven either by small reciprocating engines or by electric motors.

As the engines are usually at a considerable distance from the boiler house the steam reaches the cylinders in a wet condition, and a compounded oil is necessary. However, the service is usually continuous and the cylinders, therefore, remain warm. As a result, a steam cylinder oil with a moderate amount of compound, i.e., 5% to 8%, will operate satisfactorily. As these engines are apt to be more or less unattended their external lubrication is frequently accomplished by grease cups, using a medium grade of grease.

Splash lubrication of certain bearings, however, where enclosure is possible, is also very dependable. Under such conditions a medium viscosity engine oil will be satisfactory.



Courtesy of Link-Belt Co.

Fig. 18—An underground coal conveyor looking down from the head end. Note massive construction of moving elements, and nature of the driving mechanism.

Electric motor bearings, in turn can be either oil or grease lubricated, according to the design, construction and provisions for lubrication.

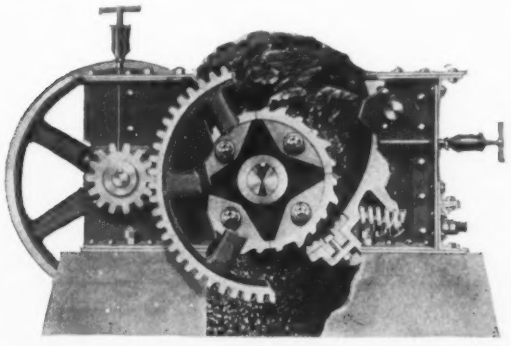
BREAKING, SORTING AND CLEANING

The extent to which breaking, cleaning and sorting will be necessary as coal is brought from the mine, will depend upon the variety of product.

As the cars full of coal are brought to the surface they are drawn to the breaker or tipple. Here they are dumped or turned over bodily, their contents dropping to a conveyor. Where large lumps are involved, crushing may be necessary prior to sorting and cleaning.

Sorting is carried out by passing the coal through large rotating or "shaking" screens. It is then taken to the picking or cleaning machines. There are in general three methods adaptable to this purpose, i. e., in the first the coal may be run down a spiral chute where rock and slate, due to its greater density, will be thrown to the outside of the chute by centrifugal force, to be effectively separated from the coal. Another method provides for passing the coal over rollers. By virtue of the lower density of the coal the rollers impart a certain amount of momentum thereto, throwing it apart from the rock and down a special chute. The rock in turn drops down close to the rollers.

The third method involves the coal jig. In principle the jig also makes use of the relative densities of coal and rock. In this apparatus the mine run product is fed into a hopper which is immersed in running water and given a reciprocating motion of about 200 strokes a minute. This causes the coal to remain in suspension to be ultimately washed over a weir. Rock and slate, however, settle to the bottom, being subsequently removed by conveyors.

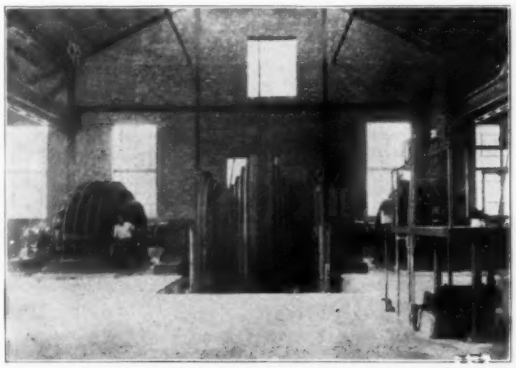


Courtesy of Pennsylvania Crusher Co.

Fig. 19—A rotary type coal crusher. Note segmental roll construction and pressure lubricating devices for grease application.

Lubrication

Grease lubrication is advantageous on coal breaking and cleaning machinery bearings, inasmuch as grease, under sufficient pressure will more effectively protect these against coal or rock dust. As a rule a medium bodied compression cup grease will adequately serve the purpose. Where such bearings are designed for oil lubrication a straight mineral machine oil of approximately 300 seconds Saybolt viscosity at



Courtesy of Nordberg Mfg. Co.

Fig. 20—The function of wire rope in the coal mining industry is of decided importance. In the hoisting of the cages, water hoist buckets, or coal from mine to tipple, wire rope undergoes most severe service. Careful lubrication and protection is therefore essential. Above is a view of the largest coal hoist in the world.

100°F. will, in general, carry the pressures satisfactorily.

Gear lubrication, in turn may develop problems, whatever the method of sorting or cleaning involved. Many of such gears, with the accessory driving chains will operate exposed on certain machines.

Where water is employed, as with the jig or washer, the lubricant must possess certain naturally adhesive characteristics in order that it may resist the washing-off effect of water. A straight mineral lubricant of approximately 1000 seconds Saybolt viscosity at 210°F. should normally withstand these conditions.

LUBRICATION OF SCREENS

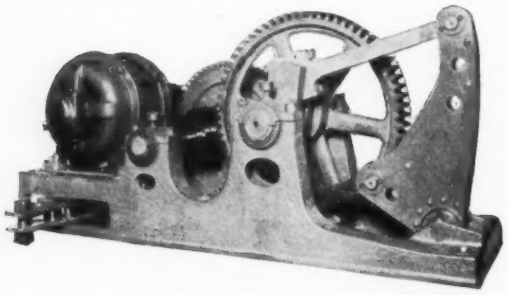
Rotary Type

Screens of this type are usually carried on two points of support—one at each end. The mechanism at the driving end of course involves the most difficulty from a lubricating point of view, especially in regard to the gears. These latter will, as a rule, operate exposed, with their lubricants subjected to contamination by dust, dirt, and probably moisture.

These conditions would, of course, also affect the bearings to a certain extent, although the housings, if properly designed and installed, would prevent at least the entry of an excessive amount of dust and dirt. In general these are plain babbitted bearings with provision for grease lubrication.

Under the prevalent operating conditions grease is probably a better lubricant than oil due to its ability to maintain a more effective

seal against entry of abrasive foreign matter. It must be a product insoluble in water, however, due to the possibility of its having to withstand the washing action of any water



Courtesy of Link-Belt Co.

Fig. 21—Assembly view of a shaker conveyor drive unit, showing grease lubricated bearings, and means whereby shaking motion is brought about.

used during screening. As a rule a product of medium body or consistency will be best suited to these conditions, and capable of ready application by means of some form of compression cup or pressure lubricator.

For the gears a lubricant must be used which will not only form a protective film to counteract the abrasive effect of dust, dirt, etc., but will function irrespective of temperature, moisture, or weather conditions. This is a broad requirement, one in fact that very few compounded lubricants or greases will meet with any degree of success. Experience has proven that a straight mineral residual product, of fairly inert characteristics, will give the most satisfactory results. Usually a viscosity of approximately 200 seconds Saybolt at 210°F. will adequately serve the purpose. On the other hand, certain conditions might require a higher viscosity of say 1000 seconds Saybolt.

Advantages possessed by heavier lubricants, however, are their highly adhesive characteristics and their capability of resisting the effects of centrifugal force under higher speed conditions provided they are sparsely applied.

Shaking Screens

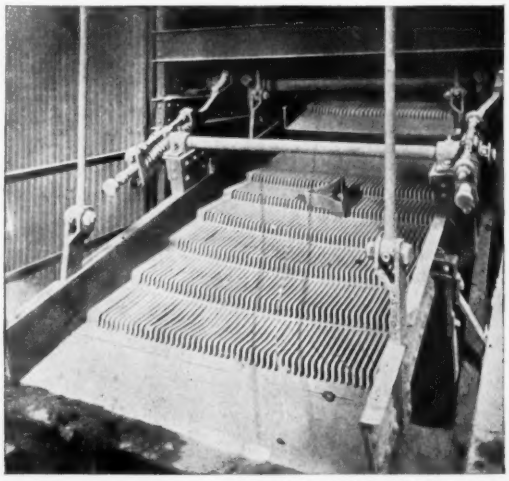
In the case of vibrating or shaking screens the vibratory mechanism is somewhat more intricate than the driving gears and bearings of a rotary screen. It may, therefore, develop more potential difficulties in regard to lubrication. Grease lubrication has been found to be very satisfactory on such equipment, affording the requisite protection to the various bearings by preventing the entry of dust and dirt. As a rule some form of compression or pressure grease lubricating device should be used to insure as nearly positive lubrication as possible. In such equipment a medium bodied compression cup grease will be suitable. Where oil, however, is desirable, as on certain types of ball bearings, a medium viscosity straight mineral product should be used.

Where cams are involved which tend to run hot a problem of under-lubrication and abnormal wear of cams and straps may frequently develop. The proper lubricant to counteract such conditions is a high melting point grease of relatively heavy consistency.

CONCLUSION

To cover the coal industry as a whole, within the space available, has been practically impossible. Effort has therefore, been made to discuss only such equipment as may more frequently involve problems of lubrication.

Conditions in the coal mine, tipple or breaker are not conducive to effective lubrication. They should not be regarded as so inevitable, however, as to warrant disregard of all due care in protection of machinery wearing elements. Judicious selection of oils and greases so refined as to best counteract these dust, dirt, water and acid conditions, will certainly result in more efficient operation, and should never be slighted. It is for this reason that equipment such as the drill, coal cutter, mechanical loader, mine car, screen, etc., have been discussed in detail. Failure in the lubrication of any of their wearing elements would probably slow down production materially.



Courtesy of The C. O. Bartlett & Snow Co.

Fig. 22—A typical shaking screen. Vibrating mechanism is grease lubricated.

Conveyors will be discussed in an early issue of LUBRICATION, from the viewpoint of their bearing on materials handling problems in general.

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